



## **NASA STTR 2006 Phase I Solicitation**

### **T8 Marshall Space Flight Center**

NASA's Marshall Space Flight Center in Huntsville, AL, develops key space transportation and propulsion technologies including the new exploration crew and cargo launch vehicles; manages space shuttle propulsion elements and science aboard the international space station; and pursues scientific breakthroughs in space that will improve human life here on Earth.

## **Subtopics**

### **T8.01 Manufacturing Technologies for Human and Robotic Space Exploration**

**Lead Center:** MSFC

**Participating Center(s):** MSFC

**Center:** MSFC

Continued technological innovation is critically linked to a strong manufacturing sector in the United States economy. NASA is interested in innovative manufacturing technologies that enable sustained and affordable human and robotic exploration of the Moon, Mars, and solar system. Specific areas of interest in this solicitation include innovative manufacturing, materials, and processes relevant to propulsion systems and airframe structures for next-generation launch vehicles, crew exploration vehicles, lunar orbiters and landers, and supporting space systems. Improvements are sought for increasing safety and reliability and reducing cost and weight of systems and components. Only processes that are environmentally friendly and worker-health oriented will be considered. Proposals are sought, but are not limited to, the following areas:

#### **Polymer Matrix Composites (PMCs)**

Large-scale manufacturing; innovative automated processes (e.g., fiber placement); advanced non-autoclave curing (e.g., e-beam, ultrasonic); damage tolerant and repairable structures and self-healing technologies ; advanced materials and manufacturing processes for both cryogenic and high-temperature applications; improved thermal protection systems (e.g., integrated structures, integral cryogenic tanks and insulations) .

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## **Ceramic Matrix Composite (CMCs) and Ablatives**

CMC materials and processes are projected to significantly increase safety and reduce costs simultaneously while decreasing system weight for space transportation propulsion. Advanced CMC, ablative, and insulation materials and processing technologies are of interest which have low volume at low cost and are repeatable and scalable to large sizes. Applications of interest include, but not limited to: solid propulsion nozzles and throats, liquid propulsion nozzles and thrust cells with integral injectors, and ancillary hardware components necessary for earth-to-orbit and in-space transportation.

## **Metals and Metal Matrix Composites (MMCs)**

Advanced manufacturing processes such as pressure infiltration casting (for MMCs); laser engineered near-net shaping; electron-beam physical vapor deposition; in situ MMC formation; solid state and friction stir welding, which target aluminum alloys, especially those applicable to high-performance aluminum-lithium alloys and aluminum metal-matrix composites; advanced materials such as metallic matrix alloys compositions, which optimize high ductility and good joinability; functionally graded materials for high- or low-temperature application; alloys and nanophase materials to achieve more than 120 ksi tensile strength at room temperature and 60 ksi at elevated temperature above 500° F; new advanced superalloys that resist hydrogen embrittlement and are compatible with high-pressure oxygen; innovative thermal-spray or cold-spray coating processes that substantially improve material properties, combine dissimilar materials, application of dense deposits of refractory metals and metal carbides, and coating on nonmetallic composite materials.

## **Manufacturing Nanotechnology**

Innovations that use nanotechnology processes to achieve highly reliable or low-cost manufacturing of high-quality materials for engineered structures.

## **Fiber-Based and Inflatable Systems**

Fabrics and films may be appropriate materials for some space structures, but significant research is required to investigate the benefits, challenges and failure modes of such systems. Where fiber-based or inflatable structures have been demonstrated as potentially valuable to NASA, quality-controlled manufacture of these structures will be a strong focus and interaction between designers, manufacturing specialists and performance analysts can lead to better products; innovative procedures for manufacturing improvements and concepts are of interest.

## **Advanced NDE Methods**

Portable and lightweight NDE tools that take advantage of nanotechnology for noninvasive, noncontact area inspection and characterization of polymer, ceramic and metal matrix composites. Areas include but are not limited to microwaves, millimeter waves, infrared, laser ultrasonics, laser shearography, terahertz, and radiography.

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## **T8.02 Component Development for Deep Throttling Space Propulsion Engines**

**Lead Center:** MSFC

**Participating Center(s):** MSFC

**Center:** MSFC

Implementing certain aspects of the NASA Vision for Space Exploration will require versatile space propulsion engines that can operate over a wide range of thrust levels, a capability known as throttling. The ability of a rocket engine to reliably produce a small fraction of the maximum thrust on command during flight is referred to as deep throttling. High specific impulse deep-throttling space propulsion engines may be required for controlled spacecraft descent to planetary surfaces, and a significant degree of throttling may also be required for ascent and in-space transfer maneuvers.

This subtopic solicits partnerships between academic institutions and small businesses in the development of components, design tools, and performance databases for engines in the 5,000-15,000 pound thrust range that use liquid hydrogen and liquid oxygen as propellants and which can be throttled to as little as 7% of the maximum thrust value. Examples of specific areas where innovations are sought include:

- High-throttle-response engine concepts;
- Low-cost regeneratively cooled chamber designs and demonstrations of such;
- Injectors that can provide stable engine performance with two-phase (gas/liquid) flow of propellants, especially during start-up transients;
- Ignition systems that can operate reliably over a wide fuel/oxidizer mixture ratio;
- Propulsion system or component technologies that do not require thermal conditioning prior to ignition;
- Zero net positive suction pressure pump design concepts, and demonstrations of such;
- Performance databases for small turbopumps and turbomachinery components;
- Design and analysis tools that accurately model small valves and turbopumps, and data required for code validation;
- Alternatives to the use of turbopumps for achieving chamber pressures of 1000 pounds per square inch; and
- Instrumentation for integrated vehicle health management.

